

I claim:

- 1 1. A method for improving performance of an engine comprising:
2 contacting contaminated liquid hydrocarbon fuel comprising an initial
3 concentration of drag reducer additive ("DRA") with one or more
4 effective DRA removal agent(s) under conditions effective to produce
5 decontaminated liquid hydrocarbon fuel comprising a reduced
6 concentration of said DRA; and,
7 feeding said decontaminated liquid hydrocarbon fuel to said engine.
- 1 2. The method of claim 1 wherein said one or more effective DRA
2 removal agents achieve a % DRA removal of about 10% or more when 1 g of the
3 DRA removal agent is added in increments with agitation to 100 ml. of contaminated
4 liquid hydrocarbon fuel comprising from about 8 to about 12 ppm of unsheared target
5 DRA.
- 1 3. The method of claim 2 wherein said % DRA removal is about 20% or
2 more.
- 1 4. The method of claim 2 wherein said % DRA removal is about 30% or
2 more.
- 1 5. The method of claim 2 wherein said % DRA removal is about 40% or
2 more.
- 1 6. A method for improving performance of an engine comprising:
2 contacting contaminated liquid hydrocarbon fuel comprising an initial
3 concentration of drag reducer additive with one or more effective DRA
4 removal agent(s) selected from the group consisting of graphites,
5 activated carbons, fresh attapulgus clay, and combinations thereof,

6 under conditions effective to produce decontaminated liquid
7 hydrocarbon fuel comprising a reduced concentration of said DRA;
8 and,
9 feeding said decontaminated liquid hydrocarbon fuel to said engine.

1 7. The method of claim 6 wherein said one or more DRA removal agents
2 have an adsorption capacity of about 0.03 wt.% or more.

1 8. The method of claim 6 wherein said conditions comprise incremental
2 addition of the DRA removal agent(s) and agitation of the resulting mixture.

1 9. The method of claim 6 wherein said conditions comprise passing the
2 contaminated liquid hydrocarbon fuel through a bed comprising said one or more
3 effective DRA removal agent(s).

1 10. The method of claim 9 wherein said contacting produces used DRA
2 removal agent(s), said method further comprising replacing said used DRA removal
3 agent(s) with fresh DRA removal agent(s).

1 11. The method of claim 6 wherein said contacting said contaminated
2 liquid hydrocarbon fuel comprising an initial concentration of DRA with one or more
3 effective DRA removal agent(s) occurs at a location selected from the group
4 consisting of: at a refinery; between a refinery and a fuel terminal; at a fuel terminal;
5 between two different fuel terminals; between a fuel terminal and an airport storage
6 tank; at an airport storage tank; between a fuel terminal and a tanker truck; at a tanker
7 truck; between an airport storage tank and a tanker truck; between two different
8 tanker trucks; between a tanker truck and an engine, at a fuel dispenser; between a
9 fuel dispenser and a vehicle comprising the engine; and, at the engine.

1 12. The method of claim 6 further comprising preheating said one or more
2 removal agents prior to use under conditions effective to remove adsorbed water
3 without damaging the removal agent(s).

1 13. The method of claim 6 wherein said reduced concentration of DRA is
2 sufficiently low to perform one or more function selected from the group consisting of
3 permitting reignition of jet fuel after flameout, decreasing plugging of fuel filters and
4 reducing formation of deposits on engine components selected from the group
5 consisting of intake valves, combustion chambers, and fuel injectors.

1 14. The method of claim 6 wherein said liquid hydrocarbon fuel has a
2 boiling range of from about 150 °F to about 750 °F.

1 15. The method of claim 6 wherein said liquid hydrocarbon fuel is selected
2 from the group consisting of liquefied natural gas (LNG), liquefied petroleum gas
3 (LPG), motor gasoline, aviation gasoline, distillate fuels such as diesel fuel and home
4 heating oil, kerosene, jet fuel, No. 2 oil, residual fuel, No. 6 fuel, or bunker fuel.

1 16. The method of claim 6 wherein said liquid hydrocarbon fuel is selected
2 from the group consisting of diesel fuel, jet fuel, aviation gasoline, and motor
3 gasoline.

1 17. The method of claim 6 wherein said liquid hydrocarbon fuel is jet fuel.

1 18. The method of claim 17 wherein said reduced concentration of DRA is
2 sufficiently low to permit reignition of jet fuel after flameout.

1 19. The method of claim 6 wherein said drag reducer additive comprises a
2 polyalphaolefin having a peak molecular weight of about 1 million Daltons or more.

1 20. The method of claim 18 wherein said polyalphaolefin has a peak
2 molecular weight of about 10 million Daltons or more.

1 21. The method of claim 6 wherein said DRA comprises two different
2 linear alpha olefins (LAO's) or more having from about 6 to about 12 carbon atoms,
3 the number of carbon atoms of the at least two different LAO's differing by 6.

1 22. The method of claim 6 wherein said DRA comprises one or more
2 polyalphaolefins made by solution polymerization.

1 23. The method of claim 6 wherein said DRA comprises polar groups.

1 24. The method of claim 23 wherein said DRA comprises organic polar
2 groups.

1 25. The method of claim 23 wherein said polar groups comprise a moiety
2 selected from the group consisting of oxygen, sulfur, nitrogen, halogen, phosphorus,
3 unsaturated carbon-carbon bonds, and combinations thereof.

1 26. The method of claim 24 wherein said organic polar groups comprise a
2 moiety selected from the group consisting of oxygen, sulfur, nitrogen, halogen,
3 phosphorus, unsaturated carbon-carbon bonds, and combinations thereof.

1 27. A method for improving performance of an engine comprising:
2 contacting contaminated liquid hydrocarbon fuel comprising an initial
3 concentration of drag reducer additive ("DRA") with one or more
4 effective DRA removal agent comprising graphite under conditions
5 effective to produce decontaminated liquid hydrocarbon fuel
6 comprising a reduced concentration of said DRA; and,
7 feeding said decontaminated liquid hydrocarbon fuel to said engine.

1 28. The method of claim 27 wherein said graphite is selected from the
2 group consisting of graphite powders and graphite particulates having an adsorption
3 capacity of about 0.01 wt.% or more.

1 29. The method of claim 27 wherein said graphite comprises granules
2 having an average diameter of from about 0.01 microns to about 10,000 microns.

1 30. The method of claim 28 wherein said graphite comprises granules
2 having an average diameter of from about 0.01 microns to about 10,000 microns.

1 31. The method of claim 27 wherein said graphite comprises granules
2 having an average diameter of from about 0.1 microns to about 1,000 microns.

1 32. The method of claim 28 wherein said graphite comprises granules
2 having an average diameter of from about 0.1 microns to about 1,000 microns.

1 33. The method of claim 27 wherein said graphite comprises granules
2 having an average diameter of from about 1 micron to about 100 microns.

1 34. The method of claim 28 wherein said graphite comprises granules
2 having an average diameter of from about 1 micron to about 100 microns.

1 35. The method of claim 27 wherein said graphite is selected from the
2 group consisting of graphite powders and graphite particulates having an adsorption
3 capacity of about 0.03 wt.% or more.

1 36. The method of claim 29 wherein said adsorption capacity is about
2 0.03 wt.% or more.

1 37. The method of claim 32 wherein said adsorption capacity is about 0.03
2 wt.% or more.

1 38. The method of claim 34 wherein said adsorption capacity is about
2 0.03 wt.% or more.

1 39. The method of claim 9 wherein said adsorption capacity is about 0.04
2 wt% or more.

1 40. The method of claim 27 wherein said adsorption capacity is about
2 0.04 wt%.

1 41. The method of claim 27 wherein said graphite is selected from the
2 group consisting of natural graphites, synthetic graphites, expanded graphites, and
3 combinations thereof.

1 42. The method of claim 41 wherein said graphite is selected from the
2 group consisting of purified carbon, natural graphite, silica (crystalline quartz),
3 synthetic graphite, and combinations thereof.

1 43. The method of claim 35 wherein said graphite is selected from the
2 group consisting of purified carbon, natural graphite, silica (crystalline quartz),
3 synthetic graphite, and combinations thereof.

1 44. The method of claim 28 wherein said conditions comprise incremental
2 addition of the DRA removal agent(s) and agitation of the resulting mixture.

1 45. The method of claim 28 wherein said conditions comprise passing the
2 contaminated liquid hydrocarbon fuel through a bed comprising said one or more
3 effective DRA removal agent(s).

1 46. The method of claim 45 wherein said contacting produces used DRA
2 removal agent(s), said method further comprising replacing said used DRA removal
3 agent(s) with fresh DRA removal agent(s).

1 47. The method of claim 28 wherein said contacting said contaminated
2 liquid hydrocarbon fuel comprising an initial concentration of DRA with one or more
3 effective DRA removal agent(s) occurs at a location selected from the group
4 consisting of: at a refinery; between a refinery and a fuel terminal; at a fuel terminal;
5 between two different fuel terminals; between a fuel terminal and an airport storage

6 tank; at an airport storage tank; between a fuel terminal and a tanker truck; at a tanker
7 truck; between an airport storage tank and a tanker truck; between two different
8 tanker trucks; between a tanker truck and an engine, at a fuel dispenser; between a
9 fuel dispenser and a vehicle comprising the engine; and, at the engine.

1 48. The method of claim 28 further comprising preheating said one or
2 more removal agents prior to use under conditions effective to remove adsorbed water
3 without damaging the removal agent(s).

1 49. The method of claim 28 wherein said reduced concentration of DRA is
2 sufficiently low to perform one or more function selected from the group consisting of
3 permitting reignition of jet fuel after flameout, decreasing plugging of fuel filters and
4 reducing formation of deposits on engine components selected from the group
5 consisting of intake valves, combustion chambers, and fuel injectors.

1 50. The method of claim 28 wherein said liquid hydrocarbon fuel has a
2 boiling range of from about 150 °F to about 750 °F.

1 51. The method of claim 28 wherein said liquid hydrocarbon fuel is
2 selected from the group consisting of liquefied natural gas (LNG), liquefied petroleum
3 gas (LPG), motor gasoline, aviation gasoline, distillate fuels such as diesel fuel and
4 home heating oil, kerosene, jet fuel, No. 2 oil, residual fuel, No. 6 fuel, or bunker fuel.

1 52. The method of claim 28 wherein said liquid hydrocarbon fuel is
2 selected from the group consisting of diesel fuel, jet fuel, aviation gasoline, and motor
3 gasoline.

1 53. The method of claim 28 wherein said liquid hydrocarbon fuel is jet
2 fuel.

1 54. The method of claim 53 wherein said reduced concentration of DRA is
2 sufficiently low to permit reignition of jet fuel after flameout.

1 55. The method of claim 28 wherein said drag reducer additive comprises
2 a polyalphaolefin having a peak molecular weight of about 1 million Daltons or more.

1 56. The method of claim 54 wherein said polyalphaolefin has a peak
2 molecular weight of about 10 million Daltons or more.

1 57. The method of claim 28 wherein said DRA comprises two different
2 linear alpha olefins (LAO's) or more having from about 6 to about 12 carbon atoms,
3 the number of carbon atoms of the at least two different LAO's differing by 6.

1 58. The method of claim 28 wherein said DRA comprises one or more
2 polyalphaolefins made by solution polymerization.

1 59. The method of claim 28 wherein said DRA comprises polar groups.

1 60. The method of claim 59 wherein said DRA comprises organic polar
2 groups.

1 61. The method of claim 59 wherein said polar groups comprise a moiety
2 selected from the group consisting of oxygen, sulfur, nitrogen, halogen, phosphorus,
3 unsaturated carbon-carbon bonds, and combinations thereof.

1 62. The method of claim 60 wherein said organic polar groups comprise a
2 moiety selected from the group consisting of oxygen, sulfur, nitrogen, halogen,
3 phosphorus, unsaturated carbon-carbon bonds, and combinations thereof.

1 63. A method for improving performance of an engine comprising:
2 contacting contaminated liquid hydrocarbon fuel comprising an initial
3 concentration of drag reducer additive ("DRA") with one or more
4 effective DRA removal agent(s) comprising activated carbon under

5 conditions effective to produce decontaminated liquid hydrocarbon
6 fuel comprising a reduced concentration of said DRA; and,
7 feeding said decontaminated liquid hydrocarbon fuel to said engine.

1 64. The method of claim 63 wherein said activated carbon has an
2 adsorption capacity of about 0.01 wt.% or more.

1 65. The method of claim 63 wherein said activated carbon has an
2 adsorption capacity of about 0.02 wt.% or more.

1 66. The method of claim 63 wherein said activated carbon has an
2 adsorption capacity of about 0.03 wt.% or more.

1 67. The method of claim 64 wherein said conditions comprise incremental
2 addition of the DRA removal agent(s) and agitation of the resulting mixture.

1 68. The method of claim 64 wherein said conditions comprise passing the
2 contaminated liquid hydrocarbon fuel through a bed comprising said one or more
3 effective DRA removal agent(s).

1 69. The method of claim 68 wherein said contacting produces used DRA
2 removal agent(s), said method further comprising replacing said used DRA removal
3 agent(s) with fresh DRA removal agent(s).

1 70. The method of claim 64 wherein said contacting said contaminated
2 liquid hydrocarbon fuel comprising an initial concentration of DRA with one or more
3 effective DRA removal agent(s) occurs at a location selected from the group
4 consisting of: at a refinery; between a refinery and a fuel terminal; at a fuel terminal;
5 between two different fuel terminals; between a fuel terminal and an airport storage
6 tank; at an airport storage tank; between a fuel terminal and a tanker truck; at a tanker
7 truck; between an airport storage tank and a tanker truck; between two different

8 tanker trucks; between a tanker truck and an engine, at a fuel dispenser; between a
9 fuel dispenser and a vehicle comprising the engine; and, at the engine.

1 71. The method of claim 64 further comprising preheating said one or
2 more removal agents prior to use under conditions effective to remove adsorbed water
3 without damaging the removal agent(s).

1 72. The method of claim 64 wherein said reduced concentration of DRA is
2 sufficiently low to perform one or more function selected from the group consisting of
3 permitting reignition of jet fuel after flameout, decreasing plugging of fuel filters and
4 reducing formation of deposits on engine components selected from the group
5 consisting of intake valves, combustion chambers, and fuel injectors.

1 73. The method of claim 64 wherein said liquid hydrocarbon fuel has a
2 boiling range of from about 150 °F to about 750 °F.

1 74. The method of claim 64 wherein said liquid hydrocarbon fuel is
2 selected from the group consisting of liquefied natural gas (LNG), liquefied petroleum
3 gas (LPG), motor gasoline, aviation gasoline, distillate fuels such as diesel fuel and
4 home heating oil, kerosene, jet fuel, No. 2 oil, residual fuel, No. 6 fuel, or bunker fuel.

1 75. The method of claim 64 wherein said liquid hydrocarbon fuel is
2 selected from the group consisting of diesel fuel, jet fuel, aviation gasoline, and motor
3 gasoline.

1 76. The method of claim 64 wherein said liquid hydrocarbon fuel is jet
2 fuel.

1 77. The method of claim 76 wherein said reduced concentration of DRA is
2 sufficiently low to permit reignition of jet fuel after flameout.

1 78. The method of claim 64 wherein said drag reducer additive comprises
2 a polyalphaolefin having a peak molecular weight of about 1 million Daltons or more.

1 79. The method of claim 77 wherein said polyalphaolefin has a peak
2 molecular weight of about 10 million Daltons or more.

1 80. The method of claim 64 wherein said DRA comprises two different
2 linear alpha olefins (LAO's) or more having from about 6 to about 12 carbon atoms,
3 the number of carbon atoms of the at least two different LAO's differing by 6.

1 81. The method of claim 64 wherein said DRA comprises one or more
2 polyalphaolefins made by solution polymerization.

1 82. The method of claim 64 wherein said DRA comprises polar groups.

1 83. The method of claim 82 wherein said DRA comprises organic polar
2 groups.

1 84. The method of claim 82 wherein said polar groups comprise a moiety
2 selected from the group consisting of oxygen, sulfur, nitrogen, halogen, phosphorus,
3 unsaturated carbon-carbon bonds, and combinations thereof.

1 85. The method of claim 83 wherein said organic polar groups comprise a
2 moiety selected from the group consisting of oxygen, sulfur, nitrogen, halogen,
3 phosphorus, unsaturated carbon-carbon bonds, and combinations thereof.

1 86. A method for improving performance of an engine comprising:
2 contacting contaminated liquid hydrocarbon fuel comprising an initial
3 concentration of DRA with fresh attapulgus clay under conditions
4 effective to produce decontaminated liquid hydrocarbon fuel
5 comprising a reduced concentration of said DRA; and,
6 feeding said decontaminated liquid hydrocarbon fuel to said engine.

1 87. The method of claim 86 wherein said fresh attapulgus clay is effective
2 to remove about 10% or more of said DRA when 1 g of the fresh attapulgus clay is
3 added in increments of from about 0.02 gram to about 0.1 gram, with agitation, to 100
4 ml. of contaminated liquid hydrocarbon fuel comprising from about 8 to about 12
5 ppm of the unsheared DRA.

1 88. The method of claim 87 wherein said fresh attapulgus clay comprises
2 granules, a majority of said granules having a mesh size of from about 30 to about 90.

1 89. The method of claim 87 wherein said conditions comprise incremental
2 addition of the DRA removal agent(s) and agitation of the resulting mixture.

1 90. The method of claim 87 wherein said conditions comprise passing the
2 contaminated liquid hydrocarbon fuel through a bed comprising said one or more
3 effective DRA removal agent(s).

1 91. The method of claim 90 wherein said contacting produces used DRA
2 removal agent(s), said method further comprising replacing said used DRA removal
3 agent(s) with fresh DRA removal agents.

1 92. The method of claim 87 wherein said contacting said contaminated
2 liquid hydrocarbon fuel comprising an initial concentration of DRA with one or more
3 effective DRA removal agent(s) occurs at a location selected from the group
4 consisting of: at a refinery; between a refinery and a fuel terminal; at a fuel terminal;
5 between two different fuel terminals; between a fuel terminal and an airport storage
6 tank; at an airport storage tank; between a fuel terminal and a tanker truck; at a tanker
7 truck; between an airport storage tank and a tanker truck; between two different
8 tanker trucks; between a tanker truck and an engine, at a fuel dispenser; between a
9 fuel dispenser and a vehicle comprising the engine; and, at the engine.

1 93. The method of claim 87 further comprising preheating said one or
2 more removal agents prior to use under conditions effective to remove adsorbed water
3 without damaging the removal agent(s).

1 94. The method of claim 87 wherein said reduced concentration of DRA is
2 sufficiently low to perform one or more function selected from the group consisting of
3 permitting reignition of jet fuel after flameout, decreasing plugging of fuel filters and
4 reducing formation of deposits on engine components selected from the group
5 consisting of intake valves, combustion chambers, and fuel injectors.

1 95. The method of claim 87 wherein said liquid hydrocarbon fuel has a
2 boiling range of from about 150 °F to about 750 °F.

1 96. The method of claim 87 wherein said liquid hydrocarbon fuel is
2 selected from the group consisting of liquefied natural gas (LNG), liquefied petroleum
3 gas (LPG), motor gasoline, aviation gasoline, distillate fuels such as diesel fuel and
4 home heating oil, kerosene, jet fuel, No. 2 oil, residual fuel, No. 6 fuel, or bunker fuel.

1 97. The method of claim 87 wherein said liquid hydrocarbon fuel is
2 selected from the group consisting of diesel fuel, jet fuel, aviation gasoline, and motor
3 gasoline.

1 98. The method of claim 87 wherein said liquid hydrocarbon fuel is jet
2 fuel.

1 99. The method of claim 98 wherein said reduced concentration of DRA is
2 sufficiently low to permit reignition of jet fuel after flameout.

1 100. The method of claim 87 wherein said drag reducer additive comprises
2 a polyalphaolefin having a peak molecular weight of about 1 million Daltons or more.

1 101. The method of claim 99 wherein said polyalphaolefin has a peak
2 molecular weight of about 10 million Daltons or more.

1 102. The method of claim 87 wherein said DRA comprises two different
2 linear alpha olefins (LAO's) or more having from about 6 to about 12 carbon atoms,
3 the number of carbon atoms of the at least two different LAO's differing by 6.

1 103. The method of claim 87 wherein said DRA comprises one or more
2 polyalphaolefins made by solution polymerization.

1 104. The method of claim 87 wherein said DRA comprises polar groups.

1 105. The method of claim 104 wherein said DRA comprises organic polar
2 groups.

1 106. The method of claim 104 wherein said polar groups comprise a moiety
2 selected from the group consisting of oxygen, sulfur, nitrogen, halogen, phosphorus,
3 unsaturated carbon-carbon bonds, and combinations thereof.

1 107. The method of claim 104 wherein said organic polar groups comprise a
2 moiety selected from the group consisting of oxygen, sulfur, nitrogen, halogen,
3 phosphorus, unsaturated carbon-carbon bonds, and combinations thereof.